United States
Department of
Agriculture

Animal and
Plant Health
Inspection
Service

Plant Protection
and Quarantine

Cooperating State
Departments of
Agriculture

September 1985

ACTION PLAN

MAIZE BORER
Chilo partellus (Swinhoe)

This PPQ Action Plan or New Pest Response Guideline has not been updated since its publication date. The actions or guidelines recommended may not be appropriate now, new survey tools may be available, and chemical pesticides named may no longer be registered. This documents is posted until updated versions can be drafted and as such are only guidelines that represent the state of knowledge at the time they were written. Please consult PPQ and/or your State Plant Regulatory Official prior to implementing any recommendations listed herein.

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AUTHORIZATION

This Action Plan provides guidelines and actions for the eradication of a maize borer infestation. This Action Plan supplements information contained in the Plant Protection and Quarantine (PPQ) Treatment, Emergency Programs, and Administrative Procedures Manuals.

It is to be used in conjunction with other manuals when conducting emergency program activities. The information and instructions contained in this Action Plan were developed with and approved by representatives of cooperating States, the U.S. Department of Agriculture's Agricultural Research and Cooperative State Research Services, and affected industry.

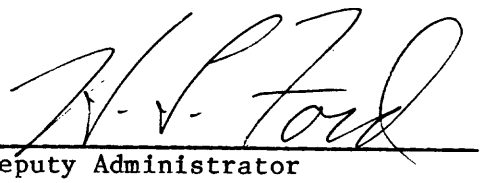
All program technology and methodology employed are determined through discussion, consultation, or agreement with the cooperating State officials.

NOTICE

Recommendations in this Action Plan, which involve the use of pesticides, concern products which are registered or exempted under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as amended. Precautions on the pesticide label and all instructions in this Action Plan must be carefully followed.

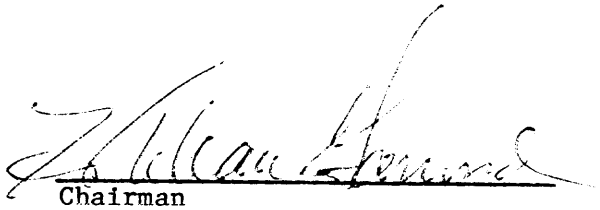
Federal and/or State personnel may not make any warranty or representation, expressed or implied, concerning the use of these products and shall not be responsible for any loss, damage, or injury sustained as a result of the use of any product as specified in this Action Plan.

The use of trade names in this Action Plan does not imply an endorsement of those products or of the manufacturers thereof by Federal-State pest control programs. Equivalent formulations under different trade names are acceptable.



Deputy Administrator
Plant Protection and Quarantine

Date



Chairman
National Plant Board

Date

I. GENERAL INFORMATION

A. Action Statement

The information contained in this document is intended for use when a maize borer infestation is known to exist. This Action Plan is to be used for guidance in implementing eradication procedures and in preventing spread to other locations. It provides technical and general information needed to implement any phase of a maize borer eradication program. Specific program action is to be based on information available at that time.

B. Background Information

The maize borer, Chilo partellus (Swinhoe), Lepidoptera, Pyralidae, is native to Asia and Africa. It occurs in Afghanistan, Bangladesh, Sri Lanka, the Comoro Islands, India, Kenya, Malawi, Nepal, Pakistan, Sikkim, Sudan, Tanzania, Thailand, and Uganda. This moth is recorded from 26 known hosts plus unidentified hosts in four genera. It has been intercepted in sorghum stem from India. The pest is a threat to the corn, sorghum, and sugarcane industries in particular, but it also represents a threat to wheat and rice. Injury occurs from boring and feeding of the larvae in the stems, stalks, and corncobs of the host. There is some leaf damage by early instars.

Development from egg to adult, in constant optimum temperature of 86 ^{o}F (30 ^{o}C) and 30 to 90 percent relative humidity, takes approximately 28 days. The adult usually becomes sexually mature after 1 or 2 days, and one generation requires approximately 30 days under these conditions.

C. Life Cycle Application

Insect development is temperature dependent. For maize borer, egg to adult reproductive development is influenced by air temperatures; larval and pupal development depends on internal host temperatures. In both environments, a minimum temperature exists below which no measurable development takes place. For maize borer, this threshold is estimated to be 45.2 ^{o}F (7.33 ^{o}C). A temperature model that is designed to use air temperature data for all life stages can be used to predict the entire life cycle. The number of degrees accumulated above the developmental threshold for a life stage are referred to as day degrees. For the model depicted in the table below, 1159 ^{o}F (644 ^{o}C) day degrees must be accumulated before one life cycle has been completed. The developmental threshold and day degree summation at 80 ^{o}F (30 ^{o}C) must be used with caution until more accurate field data are developed.

Formula:

$$\frac{\text{Minimum Daily Temp } {}^{o}F}{} + \frac{\text{Maximum Daily Temp } {}^{o}F}{} = \frac{\text{Total Temp } {}^{o}F}{2} = \frac{\text{Average Daily Temp } {}^{o}F}{} - \frac{\text{Threshold Temp } {}^{o}F}{} = \frac{\text{Day Degrees Temp } {}^{o}F}{}$$

Example: (Air model using a 45.2 ^{o}F (7.33 ^{o}C) threshold limit.)

$$\frac{\text{Minimum Daily } 59\ {}^{o}F}{} + \frac{\text{Maximum Daily } 64.4\ {}^{o}F}{} = \frac{\text{Total } 123.4\ {}^{o}F}{2} = \frac{\text{Average Daily } 61.7\ {}^{o}F}{} - \frac{\text{Threshold } 45.2\ {}^{o}F}{} = \frac{\text{Day Degree } 16.5\ {}^{o}F}{}$$

Program actions are guided in part by insect life cycle data. Duration and timing of eradication treatments, length and frequency of trapping activities, and regulatory functions are affected primarily by the length of time it takes to complete each stage of the life cycle. Temperature data are available from the National Oceanic and Atmospheric Administration, U.S. Department of Commerce, private, State, university, or industry sources, or can be generated by strategically placing thermometers in the program area.

II. SURVEY PROCEDURES

A. Delimiting Survey

1. There are two primary survey systems (trapping and visual) which must be used to complement each other if a maize borer infestation is to be adequately delimited.

When one or more maize borers are collected in an area, a delimiting survey will be implemented immediately to determine the population distribution.

a. Traps

(1) Blacklight

Using the site of the detection as the focal point (epicenter), 16 blacklight traps will be set out in a core area of 4 square kilometers (km^2) (1.54 mi^2) in host fields with a bias for preferred hosts and, where possible, four traps in each kilometer. Traps are to be serviced every day. Place traps in or near hosts. Traps will be maintained through three maize borer generations after the last detection.

(2) Pheromone

Blacklight trapping will be suspended if a suitable pheromone trapping system is developed. Such a system will be incorporated in future versions of this Action Plan. At present, a pheromone is available, but suitable traps and trap data are lacking. Provision for an experimental pheromone trapping system during program operations is provided in Addendum F2. This would be implemented if program difficulties with the blacklight system and/or a large maize borer infestation exist, which would call for establishment of a pheromone trapping system without delay.

b. Visual

Using the site of the detection as the focal point (epicenter), locate suitable host fields in each km of the core. Up to 100 hectares (ha) (approximately 250 acres (a)) of available host (in the stage most attractive to the insect) are to be surveyed in the core. This will include 20 ha (50 a) in each km^2 and around the epicenter where the find was made or nearest feasible

host field. A minimum of 50 plants in each field will be sampled at five locations for the presence of eggs, dead hearts, shot holes, cob infestation (in corn), stem, internode, and peduncle damage as given in Addenda D3 and F3. Plants may be dissected to aid in the discovery of larvae and pupae.

At harvest time, the host plants selected at each location will be uprooted and split in order to detect the presence of diapausing larvae.

In winter, the above activity will be replaced by surveying stubble, stalks, or corncobs at each location. Plant material is to be split and examined to detect diapausing larvae.

The visual survey will be repeated once a week in different host fields, if possible, for at least three maize borer generations.

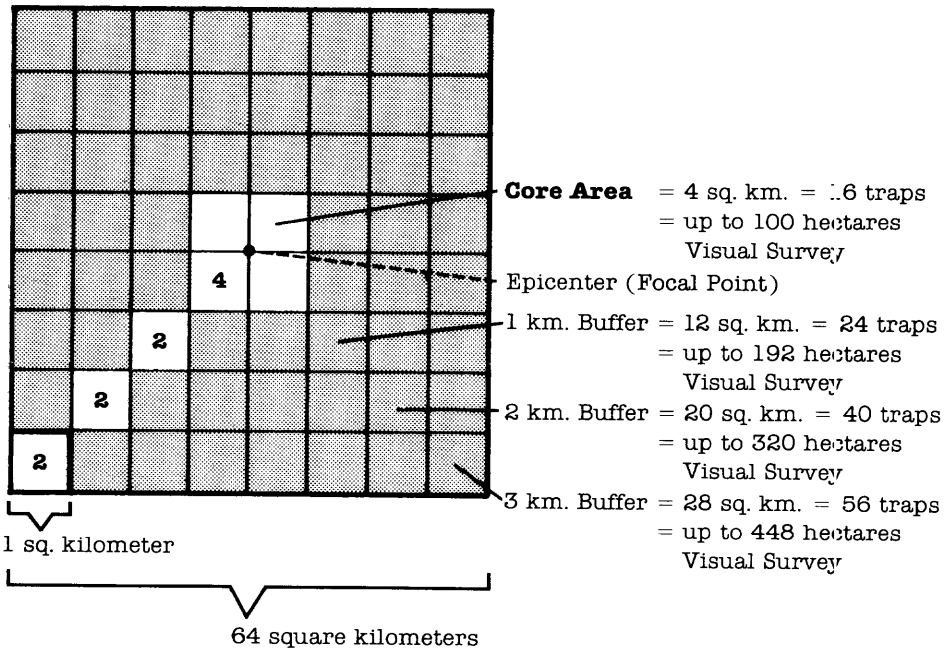
2. The extent of survey operations is given as follows:

a. If only one insect (any stage) is detected, the delimiting survey is limited to the 4-km^2 (1.54-mi^2) core area.

b. If two or more detections are made within a 4-km^2 (1.54-mi^2) area, the delimiting survey will be conducted over 36 km^2 (about 14 mi^2). Traps will be deployed in the core areas at the rate of four per km^2 and in the 1- and 2-km buffer areas at the rate of two per km^2. A larval and pupal survey will also be carried out in the core and first and second buffers, the buffer component at the rate of a minimum of 16 ha (approximately 38 a) per km^2 (approximately 100 a per mi^2).

c. If six or more detections are made in an area involving 16 km^2 (6 mi^2 or more, the delimiting survey will be conducted over a 64-km^2 (25-mi^2) area. Traps will be deployed in the core and buffer areas 1, 2, and 3 km as in b above. A larval and pupal survey will also be carried out as in b above.

Survey Per Square Kilometer



B. Monitoring/ Evaluation Survey

A monitoring/evaluation survey will be conducted in that area where eradication treatments are applied. The traps and visual survey systems are maintained at the delimiting rate. The planting of trap host crops may be beneficial in monitoring/ evaluation surveys during the subsequent growing season.

C. Host Collection and Holding

Selected hosts (corncobs, stem, stubble with larvae and pupae, and leaves with eggs) that are collected will be held for at least one maize borer life cycle at temperatures and humidity which will permit insect development for identification.

The facility where the hosts are held must be secure to prevent any inadvertent release of moths. Security measures must be equal to those established for a quarantine insect-rearing facility. See Animal and Plant Health Inspection Service 81-61 for detailed information.

D. Detection Survey

The area beyond the last buffer zone will be trapped at a minimum rate of three traps per 8 km^2 (one trap per mi^2) for two life cycles where hosts are available up to 16 km (10 mi) from the epicenter. A visual survey of at least three 4-ha (10-a) fields per 8 km^2 (one field per mi^2) will also be continued in this area for two life cycles.

Consideration should be given to prevailing winds in establishing detection survey priorities.

E. Orientation of Survey Personnel

New personnel will be trained, on the job, by experienced personnel. It will be necessary to have 3 working days to teach the many facets of the maize borer survey.

F. Survey Records

Records noting the areas surveyed, sites trapped, dates, locations, and hosts in which detections were made will be maintained (see Addendum G).

III. REGULATORY PROCEDURES

A. Instructions to Officers

Regulatory actions will be required until the pest is eradicated. Officers must follow instructions for regulatory treatments or other procedures when authorizing the movement of regulated articles. Understanding the instructions and procedures will serve as a basis for explaining such procedures to persons interested in moving articles affected by the quarantine and regulations. Only authorized treatment procedures may be used.

General instructions that are to be followed in regulatory treatments are found in the PPQ Treatment Manual.

Officers may aid shippers in selecting the authorized treatment or procedure that is most practical for the shippers. They should advise the shipper to apply selected treatments to small quantities of material prior to treating larger quantities to determine the reaction or effects of the treatment procedure. When treating commodities, which are particularly sensitive to the treatments selected, treat more of the commodity than is needed to allow for possible losses.

B. Regulated Articles

1. Any aboveground part of the following:

Common Name	Scientific Name
Corn	*Zea mays*
Grasses (All)	*Andropogon* spp.
	Coix spp.
	Eleusine spp.
	Eragrostis spp.
	Panicum spp.
	Sorghum spp.
	Trianthoma spp.
Millets (All)	*Echinochloa* spp.
	Pennisetum spp.
	Setaria spp.
Rice	*Oryza sativa*
Sorghum	*Sorghum bicolor*
Sugarcane	*Saccharum officinarum*
Teosinte	*Zea mays* var. *mexicana*
Wheat	*Triticum aestivum*
Wild Rice	*Zizania* spp.

2. Soil

3. Any other product, article, or means of conveyance, of any character whatsoever, when it is determined by an inspector that they present a hazard of spread of the maize borer and the person in possession thereof has been so notified.

C. Quarantine Actions

When detections are made, the following steps should be implemented in sequence:

1. With the detection site considered the epicenter, all growers and establishments that grow, handle, move, or process regulated articles within a minimum of 3 linear km (approximately 1.86 mi) will be issued emergency action notifications requiring treatment or other approved handling procedures. Emergency Action Notifications (PPQ Form 523) and/or comparable State notifications are issued by field personnel to the property owners or managers of all establishments that grow, handle, move, or process articles capable of spreading the maize borer. A notification will be issued pending authoritative confirmation and/or further instruction from the Deputy Administrator.

2. If necessary, the Deputy Administrator will issue a letter directing PPQ field offices to initiate specific emergency action under the Federal Plant Pest Act (7 U.S.C. 150 dd) until interim regulations announcing emergency action can be published in the Federal Register.

The Federal Plant Pest Act of 1957 provides for authority for emergency regulatory action. This provision is for interstate regulatory action only; intrastate regulatory action is provided under State authority. However, if the Secretary of Agriculture determines that an extraordinary emergency exists and that the measures taken by the State are inadequate, USDA can take intrastate regulatory action provided that the Governor of the State has been consulted and a notice has been published in the Federal Register.

The Organic Act of 1944, as amended, provides the Federal Government, either independently or in cooperation with States or political subdivisions thereof, farmers' associations and similar organizations, and individuals, the authority to carry out operations or measures to detect, eradicate, suppress, control, or to prevent or retard the spread of plant pests. This Act does not provide for trespassing on private property, but relies upon State authority and willingness to use State right-of-entry authority.

All program technology and methodology employed are determined through discussion, consultation, or agreement with the cooperating State officials.

3. The Deputy Administrator, through the National Regional Directors, will notify State cooperators of the maize borer detection, actions taken, and actions contemplated.

A narrative description of the regulated area with support documents will be developed by USDA and cooperators and provided to the Regulatory Services Staff, National Program Planning Staff (NPPS). The regulated area will also be defined by the Universal Transverse Mecator grid marking system for use by the Project Manager.

4. APHIS Regulatory Coordination Staff will publish interim regulations, which are effective on publication, under the Federal Plant Pest Act in the Federal Register to announce an emergency action. Written comments will be solicited (for approximately 60 days) on the rule from the public. If a quarantine is warranted after consideration of submitted comments, a final rule under the Plant Quarantine Act will be published in the Federal Register.

D. Regulated Establishments Inspection

Efforts to detect the pest within the regulated area will be made at all establishments where regulated articles are grown, handled, moved, or processed. Establishments that might be involved are: Airports, landfill sites, mills, farmers' markets, produce markets, nurseries, flea markets, and any other establishments that handle regulated articles. At these premises, a visual examination of host material and containers will be necessary to detect the presence of larvae and pupae, particularly where sugarcane stalks or corncobs are handled. Suspect stalks or corncobs that appear to be bored or otherwise in poor shape, will be split and examined, as will any other host material such as stems, joints, etc. If there appears to be a large number of suspect stalks or corncobs, it may be necessary to take a large biased sample (i.e., sample of suspect material) from stockpiles for examination. A minimum of 20 samples of five selections each may be examined at each establishment. At the discretion of the examining officer, one blacklight or

pheromone trap per establishment may be set and serviced for one night out of each week when trap catch of all insects is high or left to run nightly and serviced weekly when trap catch is low.

E. Use of Authorized Chemicals

The PPQ Treatment Manual and this Action Plan contain the authorized chemicals, methods and rates of application, and any special application instructions. Concurrence by the PPQ's Survey and Emergency Response Staff (SERS) is necessary for the use of any chemical or procedure for regulatory purpose.

F. Approved Regulatory Treatments

1. Fumigation. The application of an approved fumigant as a treatment (methyl bromide).

2. Dry Heat. The use of high temperatures as a treatment on selected products alone or in conjunction with fumigation procedures.

3. Steam Sterilization. The use of live steam as a treatment on selected products.

4. Cold Treatment. Temperatures below 32 ^{o}C (0 ^{o}F) for long periods may be appropriate.

5. Sanitation. The regular removal and destruction of stems, stalks, corncobs, and other host material from premises, establishments, and vehicles handling regulated articles.

G. Principal Activities

The following identifies principal activities necessary for conducting a regulatory program to prevent the spread of maize borer. The extent of regulatory activity required is dependent on the degree of infestation. For example, safeguarding vegetable stands throughout the entire regulated area which are engaged in only local retail activity may not be necessary when the regulations that are imposed are based on a limited and light infestation. On the other hand, mandatory checks of passenger baggage (i.e., for corncob dolls) at airports and the judicious use of road patrols and roadblocks may be necessary where general or heavy infestations occur.

1. Advising regulated industry of required treatment procedures.

2. Supervising, monitoring, and certifying commodity treatments of commercial lots of regulated articles.

3. Contact visits with:

   a. Security and airline personnel.
   b. Vegetable stands.
   c. Local growers, packers, mills, and seed companies.
   d. Farmers', produce, and flea markets.
   e. Commercial haulers of regulated articles.
   f. Public transportation.
   g. Nurseries.

4. Visiting canneries, graineries, and other processing establishments.

5. Monitoring the movement of waste material to and from landfills to ensure adequate disposal of regulated article refuse.

6. Monitoring the movement of regulated articles through major airports and other transportation centers.

7. Movement of host materials along major highways and across quarantine boundaries.

H. Orientation of Regulatory Personnel

Only trained or experienced personnel will be used initially. Replacement personnel will be trained by the individual being replaced. A training period of 3 working days is necessary for the orderly transfer of these functions.

I. Regulatory Records

Records will be maintained, as necessary, to carry out an effective, efficient, and responsible regulatory program (see Addendum G).

IV. ERADICATION PROCEDURES

The SERS, in consultation with methods and research agencies, outlines treatments to be used and must be notified of all treatment plans. If treatments selected or proposed are not in conformance with current pesticide labels, an emergency exemption can be provided under Section 18 of the FIFRA, as amended. For further instructions, see Emergency Programs Manual, Section V, B.

Eradication of a maize borer infestation is essential. Local conditions will determine the most acceptable procedure to achieve eradication.

A. Recommended Pesticides

1. Acephate
2. Carbaryl
3. Diazinon®
4. Trichlorfon

B. Approved Eradication Treatments

1. Aerial Spray

Aerial application of insecticide should be initiated immediately. Aerial sprays will be applied at the prescribed intervals over a minimum period equal to two life cycles. The number of applications will vary depending on the day degree accumulations in the infested area. The area to be sprayed will extend a minimum of 3 linear km (1.86 mi) beyond any known infestation. Weather conditions may dictate changes in the spray schedule. After an estimated two generations of negative survey, spray operations may be discontinued.

2. Ground Spray

On properties which cannot be aerially sprayed or where inclement weather precludes the use of aerial treatments, ground treatments may be used. Ground application of insecticide will be initiated immediately. All host plants which provide for reproduction of the maize borer on the infested property, adjacent property, and within 200 meters (m) (216 yards (yd)) of the known infestation will be sprayed at the prescribed intervals. If host material is intermittent or otherwise continuous and covers adjacent properties with substantial host material, ground application will be applied to host material to a minimum of 3 linear km

(1.86 mi) beyond any known infestation. Ground spraying may be discontinued after an estimated two generations of negative survey or after the initiation of aerial treatment.

The decision to apply insecticide applications will be based on the best weather information available. In the event rain washes an application from the foliage, plans will be implemented to retreat the area.

Retreatment should not be considered if weather reports indicate a 50 percent or greater chance of precipitation in the 48-hour period following application.

The objectives are to eradicate the pest and minimize environmental contamination. Any treatment or retreatment recommendations must consider these objectives.

3. Supplemental Methods

a. Sanitation: Sanitation in plantations, nurseries, farms, gardens, and other establishments where hosts are present will be carried out when practical within the core and buffer areas.

b. Host Destruction: In situations with a very limited area of infestation, consideration will be given to the destruction of host crops by disking or plowing, if practical. In cases of such destruction, all host material must be completely destroyed by disking, flailing, or plowing followed by leaving the material exposed on the surface, removal and burial, or incineration and burial.

c. Grass Clearance: Any wild grasses with an erect, solid stem will be destroyed, on discovery, by removal and burial, herbicidal application, cutting and disking, or incineration.

C. Eradication/ Control Method Selection

The following parameters or criteria will determine the minimum treatments to be used in achieving eradication. Expanded or additional treatment actions can be applied if mutually agreed upon by cooperating agencies.

Eradication measures will continue for at least two generations and trapping will continue for at least three generations following the last detection.

1. If one adult male or one unmated adult female is detected in an urban/residential or commercial area, no eradication treatments will be initiated.

2. When one to five mated females, larvae, or pupae, or two to five males/unmated females are detected in an area of less than 16 km^2 (6 mi^2), sanitation, host destruction after harvest, grass clearance, and ground applied foliar sprays will be employed. Similar detections in a commercial area will require treatment by sanitation, host destruction after harvest, grass clearance, and ground or aerial sprays, as applicable.

3. When more than six detections of any stage(s) are detected in an area greater than 16 km^2 (6 mi^2), ground and aerial applications will be employed, include, and extend 3 linear km (1.86 mi) beyond the known infestation. Sanitation, host destruction after harvest, and grass clearance will only be employed adjacent to finds and where practical.

D. Orientation of Eradication/Control Personnel

Only trained and experienced personnel will be utilized initially. Replacement personnel will be trained by the individual being replaced. A period of 3 working days is necessary for the orderly transfer of these functions.

E. Eradication/Control Records

Records noting the location of detections, dates, number and type of treatments, and materials and formulations used will be maintained for all areas treated (see Addendum G).

F. Monitoring

An effective monitoring program will be implemented to aid in the evaluation of program efforts and environmental impact. The application and use of insecticides and other controlled substances will be assessed through the use of appropriate monitoring program criteria. The evaluation must effectively address Agency, cooperator, and public concerns.

The monitoring program will include at least the following elements:

1. Determine efficacy of pesticide against target pest.

2. Evaluating dye cards to monitor aerial application.

   a. Droplet size information.
   b. Droplet distribution information.
   c. Identification of wind drift components.
   d. Verification of spray block boundaries.
   e. Identification of skips.

3. Sampling to evaluate effect on environmental components.

   a. Water sampling to detect insecticide levels through direct application, leaching, and runoff.
   b. Soil sampling to determine insecticide levels and residues.

c. Foliage sampling to identify residues.
d. Biological organism sampling during applications and post-treatments to determine impact of insecticides.
e. Air sampling to determine presence of pesticides in respirable air.

The monitoring program is to be a combined effort between the State in which the emergency program is being conducted and PPQ. If specific plans need to be developed for monitoring activities, the SERS will request assistance and guidelines from other NPPS staffs.

V. CONTACTS

When a maize borer eradication program has been implemented, its success will depend upon the voluntary cooperation, assistance, and understanding from other involved groups. The following is a list of groups which either are involved in or must be kept informed of all operational phases of an emergency program.

A. Commercial interests;

B. Foreign agricultural interests;

C. General public;

D. Grower groups;

E. National, State, and local news media;

F. Other Federal, State, county, and municipal agricultural officials;

G. Public health agencies;

H. State and local law enforcement officials; and

I. Universities.

VI. ADDENDA

Addendum A--Definitions

Aerial Treatment:	Applying spray by aircraft over a treatment area.
Buffer Area:	The area extending beyond the boundary of the core--1-, 2-, and 3-km buffer.
Chilo partellus (Swinhoe):	The scientific name of the maize borer.
Commercial Production Area:	An area where host material for commerce is grown.
Confirmed Detection:	A positive laboratory identification of a submitted life form (specimen) as maize borer.
Core Area:	A minimum distance of 1 km (0.6 mi) in all directions of any confirmed maize borer detection.
Day Degrees:	The accumulation of heat units above a specified developmental temperature threshold during a life stage.
Dead Heart:	The central growing shoot of a plant after it is killed due to pest activity.
Delimiting Survey:	Determining the extent of the infestation in an area where maize borer has been detected.
Detection:	The collection of any life stage of maize borer.
Detection Survey:	A survey conducted in a susceptible area not known to be infested with maize borer.
Dry Heat:	The use of high temperatures as a treatment on selected products alone or in conjunction with fumigation procedures.
Epicenter/Focal Point:	The initial site of an infestation.
Fumigation:	The application of an approved fumigant as a treatment (methyl bromide).

Generation: (Life Cycle)	The period of time for the pest to complete all stages of development predicated on day degrees or on the basis of other biological information.
Ground Spray:	Using ground spray equipment to apply an insecticide to host vegetation in a maize borer infested area.
Host:	A plant species that provides for the potential reproduction of the maize borer.
Host Collection/ Holding Survey:	The collection and holding of host material to determine the extent and nature of an infestation.
Host Destruction:	Rendering host material unsuitable for pest development through the use of mechanical or chemical means or processing.
Infestation:	The collection of two or more maize borer moths, a pupa, a larva, or a mated female from an area or the detection of a single adult determined to be associated with a current infestation.
Infested Area:	Three kilometers distance from all detection sites unless biological factors indicate the need for more or less area.
Monitoring/Evaluation Survey:	Using interdependent visual and trapping surveys in an area where an insecticide treatment has been applied to evaluate the effectiveness of the application.
PPQ-APHIS-USDA:	Plant Protection and Quarantine, Animal and Plant Health Inspection Service, United States Department of Agriculture.
Regulated Area:	An area that extends at least 3 linear km (1.86 mi) in any direction from an infested property.
Regulatory Inspection:	Visual examination of host material and containers plus discretionary trapping conducted around establishments where regulated articles are grown, handled, processed, or moved.
Steam Sterilization:	The use of live steam as a treatment on selected products.
Tiller:	A side shoot arising from the base of a plant.

Trap Survey:	Determining the presence or absence of a pest by the use of blacklight and/or pheromone traps placed in a predetermined pattern and serviced on a given schedule.
Urban/Residential Area:	Noncommercial crop production area generally containing multiple or single family dwellings.
Visual Survey:	Examining hosts for eggs, larvae, pupae, adults, or visible damage either in the field, in regulated establishments, or in monitoring the movement of regulated articles.
White Heads:	Panicles with only a few filled grains as a result of pest activity.

Addendum B--Safety

Personnel and public safety must be prime considerations at all times. Safety practices should be stressed in preprogram planning and through the duration of actual program operations. Supervisors must enforce on-the-job safety procedures. For complete instructions, see V, D in the Emergency Programs Manual.

Addendum C--Hosts

The maize borer host list is separated into preferred and other recorded hosts. The hosts are listed by common and scientific names. The common names are arranged in a manner that is indicative of their usage. The common names of a particular group or family of hosts are listed first. In all instances, an attempt has been made to use the most widely recognized common name.

PREFERRED

Common Name	Scientific Name
Adlay millet	*Coix lachryma-jobi*
Corn	*Zea mays*
Finger millet	*Eleusine coracana*
Japanese millet	*Echinochloa crugalli* var. *frumentacea* = *Panicum crugalli* var. *frumentacea*
Pearl millet	*Pennisetum americanum*
Sorghum	*Sorghum bicolor*
Sugarcane	*Saccharum officinarum*
Teosinte	*Zea mays* sub sp. *mexicana* = *Euchalena mexicana*

OTHER

The literature indicates these hosts will permit maize borer development, but does not disclose all the conditions under which the host/pest relationship occurs.

Common Name	Scientific Name
Buffelgrass	*Cenchrus ciliaris*
Burger	*Polytoca barbata*
Dropseed, a	*Sporobolus marginatus*
Elephant grass	*Pennisetum purpureum*
Eleusine	*Eleusine* spp.
Foxtail millet	*Setaria italica*
Goosegrass	*Eleusine indica*
Grass, a	*Eleusine verticillata*
	Trianthoma monogyna
	Saccharum munja
	Lepturus repens
	Saccharum sera
	Sorghum arundinaceum
Grasses, wild	*Andropogon* spp.
	Eragrostis spp.
	Sorghum spp.
Guinea grass	*Panicum maximum*

Hedgehog grass, a	*Echinochloa haploclada*
Pearl millet	*Pennisetum americanum*
Perennial, a	*Launaea cornuta*
Rice	*Oryza sativa*
Wheat	*Triticum aestivum*
Wild rice	*Zizania* spp.

Addendum D--Life History

1. SYSTEMATIC POSITION

Maize borer, Chilo partellus (Swinhoe)--(Lepidoptera, Pyralidae, Ancylolomiinae), synonym Chilo zonellus (Swinhoe)

Class:	Insecta
Order:	Lepidoptera
Family:	Pyralidae
Subfamily:	Ancylolomiinae

The genus has about 50 species, the majority in the African and Asian Regions. Only a few species are of economic importance. Related economic species are:

Asiatic rice borer, C. suppressalis (Walker)
Dark-headed striped borer, C. polychrysus (Meyrick)
Rice stalk borer, C. plejadellus Zincken

Chilo plejadellus and C. suppressalis occur in Hawaii. Two species of Chilo, C. demotellus and C. erianthalis, occur in the continental United States, but are not of economic importance.

Four subspecies of the maize borer are known from India.

2. IDENTIFICATION CHARACTERS

Some preidentification and sorting needs can be met by personnel assigned to the program.

Chilo partellus can generally be described as a small brown moth about 10.5 to 13 millimeter (mm) long in the male and 12.5 to 17 mm long in the female and a wing expanse of 21 to 26 mm in the male and 28 to 30 mm in the female. The forewing is rather plain (with a few black or brownish specks in the male) and lacks a fringe of white scales along the side and inner margin and has no white parabasal dash (found in Platytes spp. moths). The head possesses an ocellus behind each antenna next to the eyes (body scales may need to be cleaned away to see this feature), and this distinguishes the genus Chilo from Diatraea. Generally, the light-tan to light-brownish color of Chilo partellus will distinguish it from C. plejadellus, which has a golden sheen on the scales, and from C. demotellus and C. erianthalis which are gray to very dark gray to brown.

The larva of C. partellus can be separated from other Chilo in this country by possession of only four body stripes. The other species have five. As further reference, they also lack the extra nonsetose plates found towards the rear of the dorsal mesonotum, the metanotum, and abdominal segments (one to seven) of C. partellus. A related genus, Diatraea, also lacks these plates. Another look-

alike, Eoreuma spp., has only one setal hair (subventral seta) on the inside of the coxa where the mesosternum and metasternum meet, while C. partellus has two.

Eggs: About 1 mm long, oval or elliptical in shape, flat and creamy white at first to yellowish brown within 1 day of being laid.

Larvae: First instar, very small (1.25 mm length and 0.35 mm width on average) with a dark-brown head and prothorax and dirty-white abdomen. The head is flat dorsally and otherwise circular.

Second instar, larger (4.1 mm length and 0.75 mm width on average) with the prothoracic shield brown in back and whitish in front.

Third instar, larger (9.2 mm length and 1.3 mm width on average) with whitish-brown prothoracic shield and prominent body stripes consisting of longitudinal rows of light-brown to brown warts of varying size.

Fourth instar, larger (12.5 mm length and 2 mm width on average) with shining reddish-brown, rectangular prothoracic shield, general pinkish color from shield to hind end of larvae on dorsal side only, body with prominent stripes and distinct setae covering the body to the anal end.

Fifth instar, larger (21.2 mm length and 3 mm width on average) with prominent, reddish-brown head, black mandibles, and body stripes which are lost if the larva aestivates.

Sixth instar, larger (27 mm length and 4.6 mm width on average) with either a cylindrical dirty-white appearance with four pinkish stripes on the body, two on the sides, and two subdorsal lateral stripes passing above spiracles on abdominal segments. The prothoracic shield is chitinized and yellowish brown and the crochets on the prolegs are uniserial and arranged in a complete circle.

Pupae: Overall reddish-brown color, body appears bent. Male varies from 7.6 to 12.8 mm in length, 2.2 to 3.0 mm in width, and averages 42.12 milligram (mg) in weight; genital opening is on the ninth abdominal segment, flanked by a pair of pads.

Female varies from 11.8 to 17.2 mm in length, 2.6 to 4.2 mm in width, and averages 92.72 mg in weight; genital opening a small slit near the front margin of the eighth abdominal segment.

Adults: Overall a smallish, light-tan to light-brown moth. Male about 10.5 to 13 mm length, 2.5 to 3 mm width, wing expanse 21 to 26 mm, with whitish-brown to straw-colored forewings, usually with a streak of dark-brown to blackish scales on the costa, three rather diffuse spots on disk, a shadowy band running from apex halfway to center of hind margin, and a series of small reddish-black to black spots present on the outer margin. Hindwings a very light-straw color. Frons conical, with a distinctly horny point, underside not flattened, but smooth and without a ridge. Ocellus present behind each antenna and next to the eye. Labial palpi 2 1/2 times length of head, covered with dark-brown to whitish scales.

Female, usually much larger, about 12.5 to 17 mm in length, 3 to 4 mm width, wing expanse 28 to 30 mm. Forewings much lighter than in male, with darker scales sparser and more diffuse and bands usually indistinct. Hindwings whitish.

3. BIOLOGY

A mated female moth flies at night from dusk to dawn with an apparent peak of activity between 11 p.m to 3 a.m. Egg laying may occur at any time on the underside of the newest leaves of host plants. They are laid in clusters of 10 to 40 eggs, arranged in two or three longitudinal rows, more exceptionally in three to seven rows of 13 to 187 eggs in overlapping clusters. The female may lay from 231 to 337 eggs, sometimes in one night, but usually with a peak on the second day and complete by the third day after mating. Rarely, a female will lay up to 677 eggs in as many as 41 clusters. Overlapping of generations occurs since there are usually nine generations a year in warm areas. Under ideal conditions, 11 generations may be possible and six generations or fewer under unfavorable conditions in cooler areas. The incubation period is 4 days under optimum conditions (35 ^{o}C/95 ^{o}F) and 15 to 17 days at the lowest minimum developmental conditions on record (20 ^{o}C/68 ^{o}F).

When the larvae hatch, they first feed upon the leaves during the first three instars, making a few shotholes and dispersing to some extent over the host and to nearby hosts. Mortality is severe, but is much reduced as the older stages bore into the host. In corn, the larvae bore downwards through the central whorl, reaching the growing point of the plant. In sorghum, they attack the midrib of the leaf, crawl up towards the whorl, and later bore down into the heart or stem. Damaged leaves show, when fully developed, characteristic transverse rows of holes resembling each other in size and appearance. As the larvae move upward or downward in the stems, it results in tunnels which are filled with frass and excreta. When the growing points of young plants are destroyed, these are known as "dead hearts" that is, the central shoot dries up and dies.

This activity results in tillers growing from the base of the plant, severe stunting, early maturation, and lower yield. Corncobs are also attacked and bored from within. Sorghum or rice plants bear whiteheads--empty panicles or with only a few filled grains. Fungi and bacteria easily penetrate through the bore holes. All this boring

weakens the plant and many infested plants fall to the ground in heavy storms. Smaller hosts, such as wheat, may dry up totally, forcing the larvae to migrate to other shoots, with the result that one larva can destroy several wheat shoots during the larval period.

The larval period lasts 14 to 28 days, passing through six instars. The average duration of the first five instars is 2.5, 3.5, 4, 4.5, and 5 days respectively, a total of 19.5 days. If unfavorable conditions, i.e., drying up of host due to hot, cold, or dry weather occurs, fifth instar larvae will undergo aestivation or diapause for up to 158 days as indicated by the loss of the characteristic body stripes. During diapause, such larvae undergo the last moult to the sixth instar. There appears to be no obligatory period for diapause and the larvae remain in the dry stalks, stems, stubble, or cobs (of corn) until suitable conditions, such as springtime or a rainy period prevail again. In corn, stubble seems to be preferred for pupation, but, in sorghum, the stems are preferred.

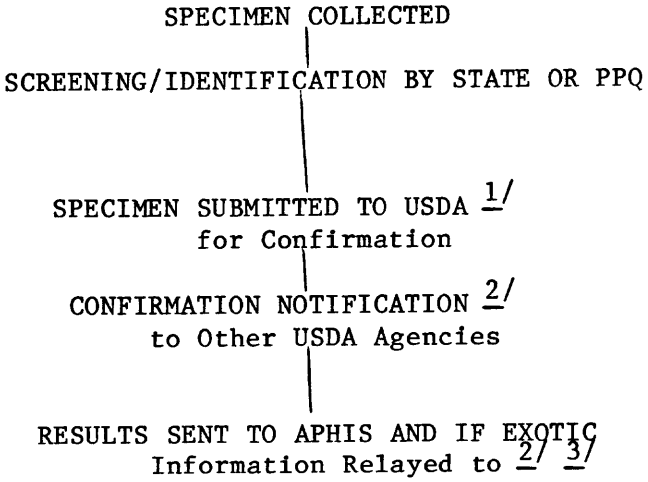
When conditions are suitable, the fully grown larva cuts a hole near one of its burrows and plugs it with silky material. The inside of the burrow is also lined with silk and the larva pupates with its head facing the closed opening. On emergence, the adult forces its way out of the pupal case, usually in early morning (2:30 to 6:30 up to 10 a.m.) and through the exit hole. This takes about 20 minutes, followed by a resting period of about 30 minutes, while the wings expand. The entire pupal stage lasts about 5 to 12 days.

Newly emerged moths wait until evening, when they become active. Mating takes place 1 or 2 days later when they are sexually mature. This generally is between midnight and 6 a.m. with actual coupling lasting from 1 to 3 hours. The preovipositional period usually lasts 1 to 3 days. The adult lifespan is relatively short--for the male varying from 2 to 4.2 days (average of 2.2 to 2.7 days) and for the female 2.6 to 6 days (average of 2.6 to 2.9 days). Generally, the total life cycle appears to average around 27 to 33 days. With diapause or aestivation, it is much longer and may extend up to 133 to 210 days.

Addendum E--Identification of Insects

As many specimens as possible of the pest are to be collected for screening/identification by the local designated identifier. Suspect adult specimens should be forwarded dry in a small cardboard box and other insect stages in vials of alcohol for confirmation to 1/ below. These specimens must be accompanied by PPQ Form 391 marked "Urgent" (see PPQ Manual M390.500).

INFORMATION FLOW FOR THE IDENTIFICATION OF INSECTS



APHIS/ARS 1/	All States 2/	NAPPO 3/

1/ ARS — Insect Identification and Beneficial Insect Introduction Institute
Agricultural Research Service
U.S. Department of Agriculture
Building 003, BARC-WEST
Beltsville, Maryland 20705

APHIS — Plant Protection and Quarantine

2/ All States — State and Territory Agricultural Regulatory Officials

3/ NAPPO — North American Plant Protection Organization

Addendum F--Technical Application Data

1. BLACKLIGHT

A blacklight trap may be used. Note: If a shortage of traps and/or resources develops as a consequence of a large, expensive operation, mercury vapor lamps may also be used. Alternatively, the number of traps outside the core areas may be reduced to one per mi^2. All traps should be properly set and timed for night operation only.

2. PHEROMONE

(Z)-11-Hexadecenal will attract other species of moths in North America, including Heliothis.

No dry-type trap has apparently been successfully employed for Chilo partellus. The water traps now in use are not suitable for an eradication program and their monitoring reliability is uncertain when compared to light traps. However, the following traps have been used as cited:

Starratt and McLeod Trap: Ostrinia nubilalis.
Pherocon 1C Trap: Chilo suppressalis.

These are low cost, disposable traps.

Traps of both the Starratt and McLeod and Pherocon 1C types will be set out in the delimiting survey area at a uniform rate of 14 traps (7 each type) per km^2. They will be located in host fields and the immediate surrounding area in a grid array and serviced twice a week. Servicing will consist of the complete replacement and disposal of each trap and lure.

After the first 2 weeks, the following possible adjustments may be made:

If either trap is not able to perform as well, consistent with projected costs, as the blacklight, this trapping system will be discontinued.

If one type of trap consistently outperforms another, the other will be replaced as soon as possible on a regular service basis.

If catches are consistently higher in a given area, i.e, field margins, nearby brush, or in the center of the host field, the trapping array will be rearranged to reflect that fact.

During the second 2 weeks, half the traps will be partly filled with a detergent and water solution and half will remain dry as before.

After the second 2 weeks, if either wet or dry traps consistently outperform the other, then that type of trap will be used for the remainder of the program. If the difference is not appreciably significant, the dry type will be employed for the remainder of the program.

During a third 2 weeks, if advisable, half the traps will be serviced at weekly intervals, the remainder at twice weekly intervals. If there is no appreciable difference in trap catch, a weekly servicing schedule for all traps will be adopted.

During a final 2-week period or indefinitely to the end of the program, and provided the trap catch is still high enough to be informative, half the traps will only have the pheromone replaced. The rest will be completely replaced at weekly or twice weekly servicing intervals. If there is no appreciable difference in trap catch, this arrangement may be continued until a difference is observed, thus fixing the service life of the traps. Trap replacement will, thereafter, follow the findings of this program.

If the final trap-type selection is consistently as effective as the blacklight array, then the latter will be completely replaced. Consistent with program needs and costs, the number of pheromone traps may then be adjusted on a per km basis to ensure a proper delimiting monitoring and detection arrangement.

Pherocon 1C Trap--Commercially available from Zoecon Corporation, P.O. Box 10975, Palo Alto, California 94303.

The trap is to be charged with a 5- by 9-mm (0.2- by 0.35-inch (in)) sleeve type rubber septum containing 0.5 gram (g) (0.18 avoirdupois ounces (av oz)) of (Z)-11-Hexadecenal. They are fastened by nails and rubberbands horizontally at a height of 1/2 m (20 in) above the crop or underlying vegetation or otherwise 1 meter (m) (3 feet (ft), 3 in) above the ground from 5 by 5 centimeter (cm) (2 by 2 in) wooden stakes, if no other support is available. Spacing will depend on the available hosts and their distribution in a given km.

Starratt and McLeod Trap--This is a trap made from a standard cardboard milk carton with a capacity of 1,893 milliliters (mL) (2 quarts (qt)) with ends removed. It is coated on the lower half of the inside with bird tanglefoot. The rubber septum is suspended inside the trap by a suitably bent paper clip. The entire trap is suspended from a stake as above.

The Pherocon 1C trap may be converted into a water trap by the simple addition of sufficient water to the bottom to a depth of at least 2.5 cm (1 in). A small amount of any detergent except extremely perfumed or bubbly brands will be sufficient to drown the moths.

The Starratt and McLeod trap may be modified by cutting off only part of the ends, so that at least 2.5 cm (1 in) of water can be retained in the trap plus some overlap. There should be 7 cm (3.76 in) of open space for the moth to fly into the trap.

3. VISUAL SURVEY

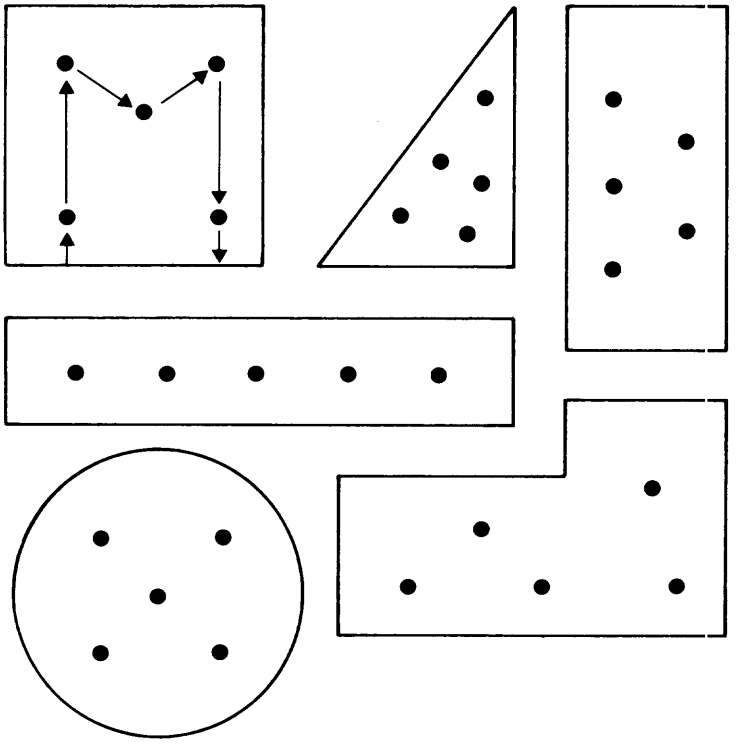
The presence of major hosts should be a criterion for the selection of fields. At the discretion of survey personnel, wild grasses which generally grow erect and possess a large solid stem (Poaceae) may be surveyed. Known hosts, however, have preference.

It may also be necessary to break very large fields into smaller units, with each unit counted as a separate field, especially if necessary to maintain survey requirements.

Host fields with tillers, fallen stalks, dead hearts, white heads, severe stunting, or that appear to be maturing early receive the first priority in the surveys.

Sampling should follow a similar pattern for each field being surveyed. Sample field borders, fence rows, or ditchbanks, especially if wild grasses fitting the general description above grow there. In this case, a separate sample may be taken, particularly if in a core area.

Field Survey Pattern



When sampling fields, enter the field at least 23 m (75 ft) from the edge and take samples at not less than five different locations in the field. Move from site to site, following a predetermined pattern such as given below:

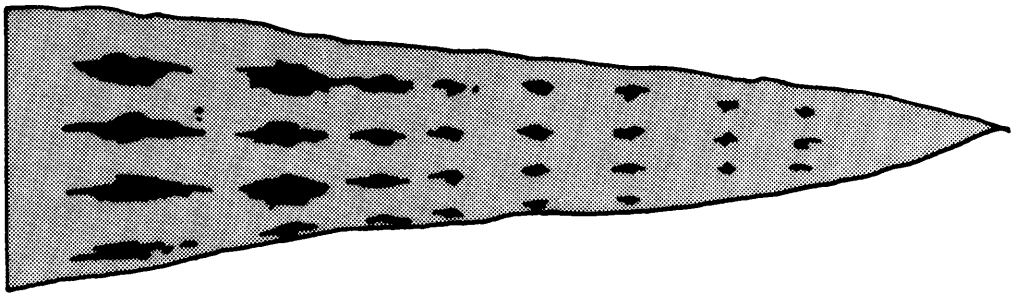
At each location, 50 plants from three adjoining rows (or equivalent spacing if no rows are present) should be inspected at random, with a bias towards those showing signs of poor growth, early maturation, tillers, white heads, shot hole leaves, dead hearts, or stem breakage. The following should be investigated:

Eggs: Look for short rows of white to yellow-brown eggs on the underside of leaves.

Larvae: Examine leaves first. Then examine to see if leaf whorls display a transverse pattern of small holes.

The same procedure should be carried out if the plant has white heads, shows signs of stem damage, borings, plugged holes, or has been blown over. Those plants with dead hearts should have the heart and any tillers split.

Figure 1—Shot Holes in Sorghum Leaf



Such a pattern indicates the presence of maize borer. The plant stalk should be split down to the base, looking for larvae/pupae or their borings. Corncobs should also be split as the larvae bore into these.

Figure 2—Shot Holes in Corn Whorl

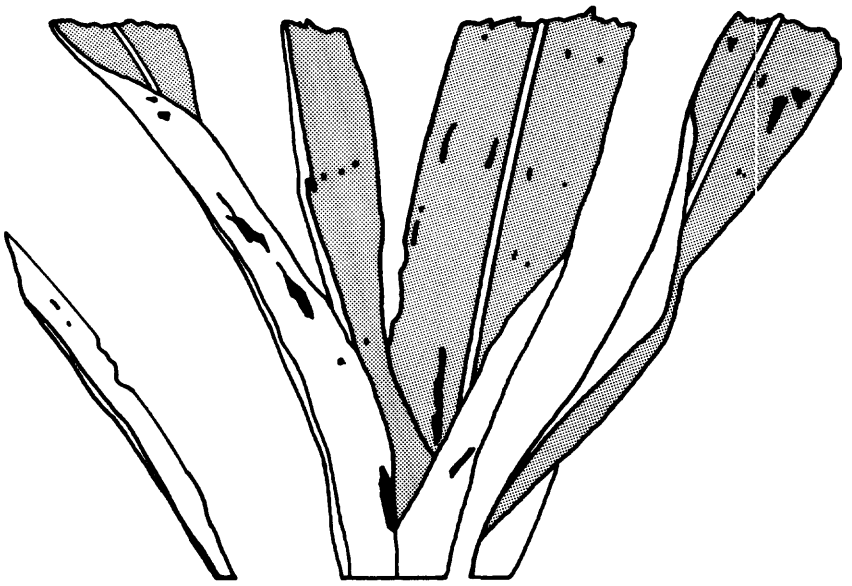
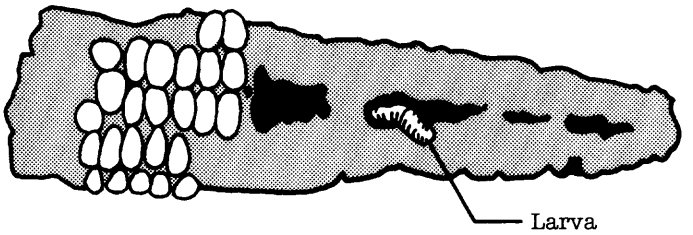


Figure 3—Larva Inside Corncob



Pupae: Examine stems, stubble, heart, and tillers of hosts, especially if dead, blown over, or exhibiting plugged holes.

If the infestation is heavy enough to warrant it, an estimate of the degree of infestation can be made. Another sample of 50 plants in the field can be taken, this time without bias towards unhealthy plants, so long as a given pattern is maintained;

i.e., every fifth plant, up to three in a row, in the first two rows, and four in the last row. The total stem length of all plants to the length of tunneled stem represents a useful ratio as does a count of all larvae and pupae in the stem or stubble, etc., of the sample and the ratio of healthy/infested plants.

4. SANITATION

Sanitation will consist of the following measures to be applied depending on the circumstances and equipment available.

a. Cleaning Fields of Vegetative Material: If the infested area is relatively small or a given field is heavily infested, this measure will be highly effective. The host material must be effectively destroyed through disking or flailing and disposal.

b. Burning of Debris: After harvest, remaining stubble should be plowed out. Then stems, stalks, stubble, and corncobs should be raked into heaps and burned. The residue can be disked under or otherwise buried in an approved landfill.

c. Plant Material: Host material may be used as ensilage. Host material may also be bagged for removal from the field. Any residue will be disposed of by complete burning or burial at an approved landfill.

d. Vehicle Inspection/Cleaning: Vehicles, trucks, tractors, wagons, etc., used in host fields or to transport host material must be inspected to ensure that accidental movement of stalks, stems, corncobs, etc., containing maize borer larvae, pupae, or eggs does not occur. Cleaning consists of the removal and destruction of any host material found.

5. GRASS REMOVAL

Certain types of grasses may be suitable hosts in this country. Grasses that have an erect or semierect solid stem or stalk large enough to allow development of larvae and pupae should be removed, destroyed, or plowed under if under suspicion for any reason, particularly those adjacent to finds. Large areas of any such grass may be treated by ground or air applications as with host crops.

6. GROUND APPLICATION

The following pesticides may not be registered for this use on a given crop. Any application inconsistent with product labeling must have prior approval.

a. Metric Measurement

Carbaryl (Sevin® Sprayable)--2.75 kilogram (kg) or 0.20 kg actual ingredient (ai) of 80 percent carbaryl in not less than 28.5 kg of water per ha. Apply as a spray when detections are made and, thereafter, approximately 5 to 10 days apart.

Trichlorfon (Dylox 80 Percent SP)--1.4 kg or 1.12 kg ai of 80 percent trichlorfon in not less than 9.5 L of water per ha. Apply as a spray when detections are made and, thereafter, approximately 15 days apart.

Acephate (Orthene® 75 S)--1.68 kg or 1.26 kg ai of 75 percent acephate in 187 to 935 L of water per ha. Apply as a spray when detections are made and, thereafter, 7- to 10-day intervals when larvae are present.

b. U.S. Measurement

Carbaryl (Sevin® Sprayable)--40 av oz or 32 av oz ai of 80 percent carbaryl in not less than (3 gallons (gal)) of water per a. Apply as a spray when detections are made and, thereafter, approximately 5 to 10 days apart.

Trichlorfon (Dylox 80 Percent SP)--20 oz or 16 av oz ai of 80 percent trichlorfon in not less than 1 gal of water per a. Apply as a spray when detections are made and, thereafter, approximately 15 days apart.

Acephate (Orthene® 75 S)--1 1/2 pound (lb) or 1.13 lb ai of 75 percent acephate in 20 to 100 gal of water per a depending on type of equipment. Apply as a spray when detections are made and, thereafter, 7- to 10-day intervals when larvae are present.

7. AERIAL APPLICATION

The following pesticides may not be registered for this use on a given crop. Any application inconsistent with product labeling must have prior approval.

a. Metric Measurement

Carbaryl (Sevin® Sprayable)--2.75 kg of 80 percent or 2.2 kg ai in not less than 9.5 L of water per ha. Apply as a spray when detections are made and, thereafter, approximately 5 to 10 days apart.

Trichlorfon (Dylox 80 Percent SP)--1.4 kg of 80 percent or 1.12 kg ai in not less than 9.5 L of water per ha. Apply as a spray when detections are made and, thereafter, approximately 15 days apart.

Acephate (Orthene® 75 S)--1.68 kg of 75 percent or 1.26 kg ai in a minimum of 18.8 L of water per ha. Apply as a spray when detections are made and, thereafter, 7 to 10 days apart when larvae are present.

b. U.S. Measurement

Carbaryl (Sevin® Sprayable)--40 oz or 32 oz ai of 80 percent in not less than 1 gal of water per a. Apply as a spray when detections are made and, thereafter, approximately 5 to 10 days apart.

Trichlorfon (Dylox 80 Percent SP)--20 oz or 16 oz ai of 80 percent in not less than 1 gal of water per a. Apply as a spray when detections are made and, thereafter, approximately 15 days apart.

Acephate (Orthene® 75 S)--1 1/2 lb or 1.13 lb ai of 75 percent in a minimum of 2 gal of water per a, depending on type of equipment and crop/host being sprayed. Apply as a spray when detections are made and, thereafter, 7 to 10 days apart when larvae are present.

8. DRY HEAT

For small lots of 25 lb (11.3 kg) or less, use a dry heat of 212 °F (100 °C) for 1 hour. Do not apply on ear corn.

For ear corn, apply dry heat at 168 °F (75.5 °C) minimum air temperature for not less than 2 hours. Ears are to be spread in single layers on slats or wire shelves.

Addendum G--Forms

To be added later.

Addendum H--Contributors

Industry

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State Regulatory Officials

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Governmental Agencies

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B. G. Lee, Assistant Director, Survey and Emergency Response Staff, National Program Planning Staff, Plant Protection and Quarantine, Animal and Plant Health Inspection Service, U.S. Department of Agriculture, Hyattsville, Maryland.

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The aforementioned individuals were major contributors to the development, preparation, and review of this Action Plan. Other contributors and/or reviewers were research scientists of Agricultural Research Service and regional and staff personnel of Plant Protection and Quarantine.

Addendum I--References

Articles on the maize borer which are relevant to this Action Plan are listed here. Also listed are lead documents on mass rearing which may eventually lead to the sterile insect technique as a viable control option.

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